Other subjects of exhibits belonging to the physical sciences were :—photographs illustrative of the Coronation Naval Review, 1902, Dr. W. J. S. Lockyer; the Cooper-Hewitt mercury vapour lamp of the British Westinghouse Electric and Manufacturing Company, Ltd., by Prof. Ernest Wilson; an automatic mercury vacuum pump, by Dr. S. R. Milner; (1) stereoscopic fluoroscope, (2) stereoscopic X-ray photographs, Mr. J. Mackenzie Davidson; detonation of small shells, Dr. O. J. Silberrad; (1) apparatus for obtaining monochromatic illumination with the microscope, (2) a new turbidimeter, for determining the turbidity of water, by Mr. Charles Baker; controlling and regulating spark discharges, experiments in illustration, by Mr. Alfred Williams.

Prof. E. B. Poulton, F.R.S., illustrated the protective resemblance of butterflies to dead leaves and fragments of dead leaves. A resemblance to entire dead leaves with mid-rib, traces of oblique veining, and often attacked by fungi, is found in many genera of tropical butterflies. Holes, when represented, appeared to have been gnawed by insects, &c. There are three stages in the representation of such holes :—(1) by opaque strongly reflecting "body colour"; (2) by transparent windows; (3) by actual apertures. In the Holarctic region, with its deciduous trees, a genus (Polygonia = Grapta) which is defended by the same kind of concealment resembles, not entire leaves, but weather-beaten and ragged fragments, and it is not a gnawed hole which is represented on the butterfly, but a curved crack due to chemical and mechanical changes in a dead leaf fragment.

The director, Royal Botanic Gardens, Kew, showed three interesting instances of plant adaptations, namely, (1) a sensitive orchid (*Masdevallia muscosa*) from New Grenada. The lip closes when an insect lights on it; the insect, in crawling out, is compelled to carry the pollen masses away with it. (2) A case of commensalism (*Dischidia rafflesiana*) from Java. Leaves become converted into bags which ants fill with soil; the plant sends roots into the "flower pots" thus formed. (3) A possible case of protective mimicry (*Mesembryanthemum Bolusii*) from South Africa. The fleshy leaves simulate the lichen-covered fragments of rock amongst which they grow.

An exhibit by Dr. D. H. Scott, F.R.S., and Prof. F. W. Oliver illustrated Lyginodendron and its seed Lagenostoma. Lyginodendron is a characteristic member of the Palæozoic group Cycadofilices, a group recognised as occupying an intermediate position between ferns and gymnosperms. Hitherto no certain knowledge of the reproductive organs of these plants has been available. A reinvestigation of the detached Coal-measure seeds belonging to Williamson's genus Lagenostoma has furnished evidence which leads to the conclusion that one of them (*Lagenostoma Lomaxi*) was borne by Lyginodendron.

Fossil vertebrata from the Fayûm, Egypt, were exhibited by the director, British Museum (Natural History). The most important of the specimens were portions of the skull of the remarkable horned mammal, Arsinoïtherium, from the Upper Eocene. Specimens of the upper and lower dentition of the primitive elephants Palæomastodon and Mæritherium were also exhibited; these showed that the teeth are comparatively simple, and that the premolars and molars are in use simultaneously as in the ordinary mammal. Remains of the elephant and antelopes associated with flint implements from the lake beds of the lake Birket-el-Kerun were also shown.

A chart representing the first results of experiments on the migrations of plaice in the North Sea was shown by the Marine Biological Association. The distances travelled by some of the fishes have been very great, amounting in one case to 160 miles in six weeks. The Association also had on view a new British species of the Polychæte family Sabellaridæ, and living representatives of the Plymouth marine fauna.

The following were also among the objects on view :—mounted specimen of newly-born Indian elephant (*Elephas maximus*), born in the Zoological Society's Gardens, showing the hairy nature of the skin, as in the mammoth, by the director, British Museum (Natural History). A series of spear-heads, manufactured by the existing Aborigines of the north-west territories of Western Australia, by Dr. Henry Woodward, F.R.S. Remains of fossil mammals from an ossiferous cavern of Pliocene age at Doveholes, near Buxton, Derbyshire, by Prof. W. Boyd Dawkins, F.R.S. Colour photographs of living insects to illustrate protective coloration and resemblance, by Mr. F. Enock. (1) Tail feathers from a common male pheasant, illustrating sexual transformation of plumage; (2) a wild duck bred in captivity showing a converse change, by Mr. S. G. Shattock and Mr. C. G. Seligmann.

During the evening Prof. E. B. Poulton gave an account of the discoveries of Mr. Guy A. K. Marshall upon the wet season and dry season forms of Rhodesian butterflies. Mr. Marshall has proved, in three cases, by breeding the one from the other, that butterflies which are entirely different in colour, pattern, shape, relation of upper side to under side of wings, and even habits, and the selection of a certain type of country, are only the summer and winter forms of one species. The winter forms are always the better concealed in these cases, probably because the butterfly passes a much larger proportion of its life in a state of complete repose.

The Bioscope Company gave a lantern demonstration illustrating the scientific and educational applications of the bioscope.

THE ENGINEERING CONFERENCE.

LAST week the Institution of Civil Engineers held the bi-annual engineering conference for the present year, under the presidency of Mr. John Clarke Hawkshaw, president of the Institution.

The proceedings commenced on the evening of Tuesday, June 16, when Mr. W. H. Maw, past-president of the Institution of Mechanical Engineers, delivered the eleventh "James Forrest" lecture in the theatre of the Institution, his subject being "Some Unsolved Problems in Engineering." We published an abridgment of Mr. Maw's address last week (p. 163). On the following day, Wednesday, June 17, the chief business of the meeting commenced, and was continued over the Thursday and Friday following. The conference was divided into seven sections, the members of which met in various rooms near the Institution house in Great George Street. These sections were as follow :—Section i., railways, chairman, Sir Guilford Molesworth; section ii., harbours, docks and canals, chairman, Sir Leader Williams; section iii., machinery, chairman, Dr. Alex. B. W. Kennedy; section iv., mining and metallurgy, chairman, Mr. E. P. Martin; section v., shipbuilding, chairman, Sir John I. Thornycroft; section vi., waterworks, sewerage and gasworks, chairman, Sir Alexander Binnie; section vii., applications of electricity, chairman, Mr. Alexander Siemens.

Before proceeding to the various section rooms, members of the congress assembled in the theatre of the Institution of Mechanical Engineers to hear an introductory address from the president of the Institution of Civil Engineers, Mr. J. C. Hawkshaw. The address alluded to the work done at past conferences, and subsequently referred to the Engineering Standards Committee, which had been organised by the Institution in conjunction with various other technical bodies. The subject of the education and training of engineers was also touched upon, and in connection with the Admiralty scheme of training, the president pointed out that a similar plan of operations was devised by the Institution for the admission of students and associate members. Referring to the pollution of the town by smoke, the president said that "neglect to deal with it is yearly costing the growing population of London a large sum, and a Royal Commission had been appointed to inquire into the subject." The problems of locomotion and transport, timber supplies, and motor-car traffic were also dwelt upon briefly.

RAILWAYS.

The section devoted to railways met on the first and second days of the meeting, five papers being read in all. The first paper was on "The Assimilation of Railway Practice as Regards Loads on Bridges up to 200 feet Span," the subject being introduced by Mr. A. Ross. It was pointed out that it was undesirable to carry standardisation

to such an extent as might tend to arrest advancement in type or design, although it was of the utmost importance that uniformity should be arrived at with regard to the loads to which such structures might be subjected. In the discussion it was suggested that loads on bridges were nearing a limit, as electric traction would probably come into use, and this would do away with the need for the heavy steam locomotive.

In a contribution on "The Design of Permanent Way and Locomotives for High Speeds," by Mr. J. C. Inglis, it was pointed out that the increase in train mileage of British railways was mostly on long distance traffic, which meant heavy trains with heavy axle loads hauled at a relatively high speed. For express running, up to 60 miles an hour, no curves should be less than 40 chains radius. Heavy rails gave smoother running, and 90 to 100 lbs. per yard was often the practice. Four-coupled engines, with the front wheels coupled and a bogie under the foot-plate, formed an undesirable class of engine for high speed running, whilst engines with single drivers, and only one axle in front and one behind, were likewise unsatisfactory, and plunged considerably, even on good roads. Equalising levers had much to recommend them, and recent practice had been in the direction of raising the centre of gravity of the locomotive.

Mr. W. J. Cudworth read an interesting paper on "Automatic Signalling," giving particulars of applications that had been made on the London and South-Western Railway and on the North-Eastern Railway. Mr. Jacomb-Hood, in the discussion, said he was convinced that automatic signalling had a great future before it.

Lieut.-Colonel Yorke, R.E., introduced the subject of "The Organisation and Administration of an American Railway," which he dealt with in some detail. He advocated the separation of the traffic or commercial department from the operating or working department, as followed in America, although unusual in this country. The value of keeping accurate statistics was dwelt upon during the discussion.

"The Relative Advantages of Overhead, Deep-level, and Shallow Subway Lines for the Accommodation of Urban Railway Traffic" was the subject brought forward by Mr. S. B. Cottrell, who discussed the respective advantages and disadvantages of the different systems.

Harbours, Docks, and Canals.

This section met on the first and last days of the congress, Wednesday and Friday, and five papers were read in all. The first paper was on "Dredging in New South Wales," Mr. C. W. Harley being the author. He pointed out that rivers were the natural means for conveying produce, and the New South Wales Government had expended considerable sums on improving its navigation. Particulars of the extensive plant that was used for this purpose were given.

The second paper on the list was "Dredging, with Special Reference to Rotary Cutters," by Mr. J. H. Apjohn. The value of hydraulic dredgers, and the results achieved on the bar of the Mersey and other rivers, were first referred to. In dealing with rotary cutters, the author pointed out that the form of the blades and the angle at which they were set, whether they were straight or spiral, and the openings between them at the bottom, were the points to be determined. Different descriptions of material needed different forms of cutters. These two papers were discussed together, Sir Leader Williams, Prof. Vernon Harcourt, Mr. Wheeler, Mr. Matthews, and others speaking. The question of "Foreshore Protection and Travel of Beaches" was next taken, the subject being introduced by Mr. W. T. Douglass. This matter was discussed at a conference at Norwich, held last January, and the author dealt with the various points raised in connection with the subject, such as direction of current, depth of water, effect of flood tides on the travel of the beach, angle and length of groynes, &c. In the course of discussion, Mr. Matthews pointed out that often the value of land reclaimed was not equal to the cost of saving it.

The other papers read in this section were "The Modern Equipment of Docks, with Special Reference to Hydraulic and Electric Appliances," by Mr. Walter Pitt; and "Recent Improvements in Canal Engineering," by Mr. Gerald FitzGibbon.

Machinery.

In the machinery section sittings were held on the Wednesday and Thursday. The first subject was introduced by Mr. Archd. P. Head, and was on "The Speed of Overhead and other Cranes as a Factor in the Economic Handling of Material in Working." The author favoured continuous current for crane work at 220 to 500 volts. He preferred this to alternate current on account of the greater starting torque and acceleration which it gave; although alternating current motors were efficient at full loads, they could only have a strong starting torque at the expense of efficiency. Continuous current also admitted of easier regulation, was cheaper in wiring, and could be stored in batteries to equalise a variable load. Series-wound motors automatically ran faster with lighter loads, and should be used coupled permanently to the gear. They could withstand 100 per cent. overload for short periods, and higher overloads momentarily, without damage. Motors running continuously with clutch connections to the gearing should be shunt-wound. Quick stopping could be achieved by an electric brake working on the armature shaft, operated by a weight or spring, and taken off by a solenoid in series with the motor. A somewhat lively discussion followed the reading of Mr. Head's paper, Mr. Tannett Walker and Mr. Ellington advocating the use of hydraulic cranes, although the latter allowed that electricity was the best source of motive power for overhead travellers.

A valuable paper by Mr. H. J. Marshall, "Gauges and Standards as Affecting Shop and Manufactory Administration," followed. The subject is one which does not well lend itself to being abstracted in a few words, but Mr. Marshall's paper is the more valuable because it represents actual experience in large works.

Mr. H. A. Humphrey's paper on "Internal Combustion Engines for Driving Dynamos" was also one of considerable interest, and attracted a good many of the electrical engineers from section vii. The author dealt with the large gas-engines which have quite recently come into use, and the design of which, unfortunately, we largely owe to the Continent, where the application of blast furnace gas to internal combustion engines has given an impetus to this branch of industry. The author stated that there were about fifty firms manufacturing large gas engines of 200 horse-power and upwards. The engines completed or on order numbered 515, having an aggregate capacity of 328,065 horse-power; of these, 398 engines were for dynamos, and gave collectively 206,805 I.H.P. The gas producer and gas engine constituted the cheapest means of generating electric power, where coal was the basis of energy, and the gas engine had proved quite trustworthy for driving alternators in parallel. He considered that ultimately the gas engine would entirely take the place of steam plant in large central electric stations. A long discussion followed the reading of this paper, in which the views of the author were upheld by some speakers. Dr. Kennedy (who occupied the chair), however, said that before he advised the application of internal combustion engines for the generation of electrical energy he would like to feel more confidence, or have more experience on the subject. Mr. Crossley and Dr. Hopkinson, who both spoke, gave some remarkable figures, showing the advantage of gas engines over steam engines in regard to economy.

"The Use of Petrol Motors for Locomotion" was the subject introduced by M. E. Sauvage, the well-known French locomotive engineer, who gave in detail the points that should be observed in designing a successful petrol motor. In the discussion, Mr. Aspinall and other locomotive engineers pointed out that though the single unit vehicle had advantages, and appeared very attractive at first sight, practical considerations militated against it, and where, in the past, the system had been tried, it had been abandoned sooner or later.

The chief feature in this section was the last paper read, which was on "Apprenticeship in Engineering Education," by Prof. J. D. Cormack. The subject is too long and too important to treat in a brief report of this nature. Prof. Cormack merely set forth the chief aspects of the question, without pretending to arrive at any conclusion,

leaving the latter task to the speakers in the discussion; of these there were no less than twenty-five. They included Sir W. H. White, Prof Kennedy, Colonel Crompton, Captain Sankey, Profs. Ayrton, Burstall and Capper, the Hon. R. C. Parsons, and Messrs. D. Drummond, A. F. Yarrow, E. B. Ellington, Bertram Hopkinson and Mark Robinson. Most diverse opinions were expressed by the various speakers, but it may be said generally that some system in which a college course would alternate with practical experience, in periods of greater or less duration, received acceptation. Sir William White, in closing the discussion, gave a promise that the matter would be considered by the council of the Institution of Civil Engineers, which would take into consideration what had been said in the section, as well as the proceedings before the Institution of Mechanical Engineers and the Institution of Naval Architects, both of which had had presented to them papers on this subject by Prof. W. E. Dalby, who recently made a tour in America and on the Continent to study this question.

Mining and Metallurgy.

Seven papers were read in this section. The first taken was by Sir Thomas Wrightson, Bart., M.P., and Mr. John Morison, the subject being "Notes on Percussive Coal Cutters." Details of the machinery were given, the authors arriving at the conclusion that in America machine coal-cutting had been successful, but in this country, up to the present, almost the opposite experience had been the result of the adoption of machinery, the economy, except in special cases, being doubtful.

"Recent Improvements in Gold-mining Machinery on the Rand," by Mr. A. E. T. Lees, followed. He dealt with the labour difficulty and its effect on the introduction of labour-saving devices. Considerable progress has recently been made in surface works, as well as certain improvements in mining machinery generally.

Mr. J. H. Harrison read a paper on "Equalising the Temperature of the Blast for Blast-furnaces, and its Effect on the Melting Zone." He gave particulars of the practice followed in America for preventing "scaffolds."

"Notes on Steam-driven and Gas-driven Blowing Engines" were contributed by Mr. Tom Westgarth, who had no hesitation in saying that the gas engine generally was more suitable for blast-furnace work, provided always that the gas saved by the use of the gas engine could be readily employed.

The remaining three papers read in this section were:—"The Continuous Method of Open-hearth Steel-making," by Mr. B. Talbot; "Alloys of Iron, Nickel and Manganese," by Mr. R. A. Hadfield; and "The Dangerous Crystallisation of Mild Steel and Wrought Iron," by Prof. J. O. Arnold.

Shipbuilding.

Section v. had five papers before it. The first was by Mr. A. F. Yarrow on "The Comparative Merits of Drilling and Punching in Steel for Shipbuilding." The author gave particulars of the British Admiralty regulations, which require drilling in place of punching for light vessels. He had found by experience that this was a wise provision, although it had been objected to by some contractors. In the discussion which followed, it was allowed that a drilled hole was better than a punched hole for light vessels, such as torpedo craft. For merchant ships, however, the greater expense of the drilling might be objected to.

Mr. John List read a paper on "Screw Shafts," pointing out the severe effects set up in them by racing in light vessels. He referred to the growing use of nickel steel for propeller shafts.

Mr. A. E. Seaton also read a paper on "The Modern Express Steamer for Short Passages," whilst Prof. A. Rateau dealt with "Steam Turbines." Mr. H. H. West contributed a paper on "Harbour Dues and Charges."

Water-works, Sewerage and Gas-works.

Five papers also were read in this section. The first was by Mr. G. T. Beilby on "Smoke Abatement." The author looked forward to the spread of the internal combustion engine and electric transmission of power to produce a better state of the atmosphere in large towns. He also considered that the firing of steam-boilers with washed gas would prove advantageous.

The next paper read was by Dr. S. Rideal, and was on "Coal-gas Standards." The subject is not one that lends itself to compression. The same may be said of Prof. Percy F. Frankland's paper on "The Bacterial Treatment of Water and Sewage." The other papers read in this section were:—"Steam Turbine-driven Centrifugal Pumps for High Lifts," by Mr. C. W. Darley; and "The Raising of Water by Compressed Air," by Mr. Percy Griffith.

Applications of Electricity.

Five papers were read in section vii. The first was on "Wireless Telegraphy," introduced by Mr. E. A. N. Pochin, who gave a review of the principles involved in this subject and of recent developments. Among important facts which have lately been established are:—(1) up to considerable ranges earth-curvature is not a fatal obstacle, but hills may exercise a serious influence; (2) the ether exhibits what we may provisionally call a variable transparency to Hertzian waves, sunlight being an important factor. With regard to both these phenomena, it is probable that certain wave-lengths offer special advantages, whilst the second affords a faint clue to the relative share of earth and ether in transmission. Amongst problems, that of isolation is undoubtedly the most important, and in this direction two methods have been employed, which may be termed respectively syntonic and optical methods, both of which were described as regards performance and promise. During the discussion which followed, Mr. Gavey expressed the opinion that syntony in installations of wireless telegraphy of from 60 to 100 miles could be established, and maintained with certainty and regularity; but for long distances transmission was uncertain, owing to causes which were not apparent. The remaining papers read in this section were on the "Applications of Electricity to Driving Carriages in Towns," by Lieut.-Colonel R. E. B. Crompton, C.B.; "The Transmission and Distribution by Single-phase Alternating Current," by Mr. E. W. Monkhouse; "High-speed Electric Traction on Railways," by J. W. Jacomb-Hood; and "The Position and Protection of the Third Rail on Electric Railways," by Mr. W. E. Langdon.

NEW CASE OF PROTECTIVE MIMICRY IN A CATERPILLAR.

IT is well known that the larvæ of many insects, such as those of the case moths, clothes moths, caddis flies, tortoise beetles, and the masked bug, construct for themselves cases or artificial coverings either for protection or concealment, and a new and somewhat remarkable instance is described by Mr. R. Shelford, the curator of the Sarawak Museum, in the *Zoologist* for May. We are indebted to the publishers for the accompanying illustration of the caterpillar described.

On May 16, 1900, a native collector brought in a quantity of a Spiræa-like plant, intended for the food of butterfly-caterpillars. It bore numerous pale green cymose inflorescences which were still in bud, and presently one of the branchlets was noticed to be moving. This proved to be due to the presence of a small Geometer caterpillar (only 9 millimetres in length) covered with buds from the inflorescence on which it was feeding. This "bore the following spine-like processes, a dorsal pair on the 4th segment, a dorso-lateral pair on segments 5, 6 and 7, a lateral pair on the 8th segment, and a short dorsal pair on the 11th; there were also some small tubercles in the positions shown in the accompanying sketch." To these spines strings of buds, connected by silk, were fastened in a similar manner, and when the green buds faded, or were removed, they were immediately replaced by fresh ones. "A bud would be shorn off with the mandibles, then held in the two front pairs of legs, and covered all over with silk issuing from the mouth of the larva; the larva then twisted round the anterior part of the body, and attached with silk the bud to one of the spinous processes, and another bud would then be attached to this, and so on, until a sufficiently long string (generally three or four buds) was made, when operations on another spine would be com-